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Cardiff Road
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1. Your reference — 577.1

2. Patent application number *(The Patent Office will fill in this part)* — 03 DEC 2003 — 0328073.2

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

   SINCLAIR, PETER
   133 FORT ROAD
   LONDON
   SE1 5PZ
   GB

   Patents ADP number *(if you know it)* — 08266223001

   If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention

   MOVING APPARATUS

5. Name of your agent *(if you have one)*

   "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

   COHEN, ALAN NICOL
   2 GROVE PLACE
   TATSFIELD
   Nr. WESTERHAM
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   TN16 2BB

   Patents ADP number *(if you know it)* — 06963557001

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
   a) any applicant named in part 3 is not an inventor, or
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   c) any named applicant is a corporate body.
   See note (d))

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9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	—
Description	12
Claim(s)	4
Abstract	1.
Drawing(s)	11 +11

8

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Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*

Request for preliminary examination and search *(Patents Form 9/77)*

Request for substantive examination *(Patents Form 10/77)*

Any other documents *(please specify)*

11. I/We request the grant of a patent on the basis of this application.

Signature

Date 2-12-03

12. Name and daytime telephone number of person to contact in the United Kingdom

A. N. Cohen 01959 577172

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Moving Apparatus

The present invention relates to a motion assist apparatus for moving or propelling objects e.g. through the air, more particularly it relates to an apparatus for assisting objects to take of vertically and fly.

Fixed wing aircraft are examples of objects which have mechanisms arranged to enable the object to controllably lift-off from the ground by utilising a runway to generate lift through forward momentum and to fly.

Helicopters are examples of mechanisms ranged to enable objects to lift off vertically from the ground and fly by utilising rotating wings.

This invention is an example of a mechanism arranged to enable the object to controllably lift off vertically from the ground and fly utilising one or two pairs of flapping wings for both lift and directional control.

A prime requirement of mechanisms or apparatus for assisting objects to fly is a low weight in relation to its power output. This is to enable there to be sufficient lift to enable the object to take off from the object of the ground.

Apart from increasing the power to weight ratio increased lift can be obtained by increasing the efficiency of the lifting mechanism. In objects with wings which generate lift by forward movement wing design and configuration are clearly important and in helicopters rotor design and size etc. are critical.

Flying insects generate lift by movement of their wings which have evolved into highly efficient and effective systems for flying. In some of such systems a wing comprises a flexible membrane which changes shape and configuration as it is moved by the insect so the insect is very maneuverable and can fly up and down and may

direction. Such systems are difficult to replicate in man made objects and previous attempts have included complex operating systems. The more complex the system the heavier it tends to be thus requirement more power etc.

A system is described in WO 03/004122.

We have now devised an apparatus for assisting in flying which reduces these problems.

According to the invention there is provided an apparatus for assisting in flying which incorporates a rotational drive mechanism, which drive mechanism comprises (i) a support member attached to a flexible wing at a first mounting point on the wing (ii) a drive means able to impart a linear oscillation to the support member (iii) a second mounting point on the wing attached to the drive means spaced apart from the support member whereby, when the drive mechanism operates the support member moves linearly and the wing flexes due to the relative motion of the support and the second mounting point to produce angular wing movement.

Preferably the drive member is an offset cam mounted on a back plate at an angle to the back plate with the support member attached to a cam follower and the second mounting point attached to the back plate.

Preferably the cam is adjustable so that the cam angle can be adjusted during motion.

Preferably there is a drive shaft connected to the axle of the drive member through a universal joint, the drive shaft and the axle of the drive member being at an angle to each other, there being a rotor connecting member mounted on the drive shaft which is connected to the drive member at one location.

The first mounting point is preferably adjacent the leading edge of the wing and the

second mounting is nearer the trailing edge of the wing. In use the drive mechanism is configured so that, as the rotor rotates, the leading edge of the wing stays substantially at the front of the wing.

Preferably the leading edge of the wing articulates separately from the rest of the wing.

The support means preferably is a rod or strut which is pivotally attached along the wing.

The back part of the wing is also pivotally mounted along its length to the wing shaft. and the trailing edge of the back part of the wing pivots e.g. up to 150 degrees (relative to the front part of the wing) around the wing shaft, and back again, while the wing shaft oscillates backwards and forwards on each full wing stroke.

On way of achieving this is to connect an articulating member to the trailing edge of the back part of the wing, parallel to the wing shaft. A second member is pivotally connected to the free end of the first member and then connected to the back plate.

A circular offset cam is mounted to the main drive shaft. A half round (amplifier) cam is mounted to the member connected to the back plate, facing inwards and making edge contact with the offset cam.
As the central cam rotates, it pushes and pulls the half cam thus causing the arm and wing to move backwards and forwards around the wing shaft.

A second way is utilises the differential movement between the cam follower member, and a portion of the back-plate. As the offset cam rotates, it causes the middle part of the cam follower member to rise and fall relative to the back plate.

When the gap is opened to its widest point, the middle has a much larger gap than where the ends meet. The gap closes in a scissor like manner from corner to middle. This is exploited by utilising the back end of the cam follower member and the edge of the side of the back plate as twin guide rails. (The faces that meet). A small bus is mounted to a rail via bearings, on the underside of the cam follower arm, and the side of the said portion of the back plate. The rail runs the full length around the cam follower member and the said portion of the side of the back plate. The busses are free to move along the rail from end to end. The busses are then pivotally hinged where one edge of one bus joins the other edge of the opposite bus.

This would mean that when the gap is at its widest, the bus components would be pulled closest to the pivot point. However as the gap closes, the bus component is squeezed by the scissor action of the apposing components and is pushed down and around the guide rails until it reaches its lowest point, before once again the guide rails opening up and pulling the bus component back to the start position.

The trailing edge of the back part of the wing is pivotally and slidably connected to the bus that is connected to the back of the cam follower member.

This configuration allows the wing to attack the air on two planes, on both the up stroke and down stroke respectively

Firstly A linear oscillation along the wing spar, produced by the rise and fall of the offset cam, connected to the cam follower, and an angular motion on the trailing edge of the back part of the wing produced by the incidental scissor type movement exploited by the bus components.

As the wing is flexible this enables the wing to generate lift.

The power source can be any motor which provides a rotary motion to the drive shaft and a flying device will incorporate at least two of the devices of the present invention mounted opposite each other which can be operated by the same power source.

In an embodiment of the invention the motor, offset cam, and cam follower components are replaced by a linear motor. One end of the linear motor being connected to the back-plate, the other end connected directly to the cam follower member in the same position as the cam follower mount.
The linear motor will oscillate producing a linear oscillation on the wing spar as the offset cam did.

The scissor motion produced by the back plate and the cam follower member, utilised for angular wing movement is unaffected.

In an embodiment of the invention the wing is oscillated simultaneously about an axis and the axis is moved linearly back and forth. The combination of these two movements can give a flexing of the wing to produce lift. By tuning the amplitude and the frequency of these two movements the wing can be made to move so that only lift is generated and substantially no negative lift is generated at any stage. A complete cycle of the wing will thus generate lift as the wing moves downwards and on the return stroke the wing is angled so that no negative lift is generated.

Conveniently the wing can be attached to sleeve or collar mounted on the axle so that the oscillating motion is imparted by movement of the sleeve over the axle and the axle is moved linearly to generate the linear motion.

There is preferably a common drive shaft which operates both movements.

In operation there are two wings driven by the same power source so that they flap together and in one way to control the direction of flight one wing is dipped and the

other raised e.g. by a twisting movement of a control rod connected to the wing and so the wing turns in the direction of the dipped wing as in a banked turn. The control rod can also be moved from side to side so the wings are moved sideways analogous to a turn using a rudder in a conventional fixed wing aircraft

The amount of lift generated will depend on the speed of rotation and the area of the wings and will be dependant on the strength of the materials, particularly the wings. A flying device will be able to vertically, fly forwards, backwards, turn in mid air, and land. The mechanism is able to reproduce a defined wing-beat pattern of over twenty beats per second.

The size and shape of wings used with the wing mechanisms has a direct bearing on the wing speed. If sufficient speed is achieved, a pair of wings having an A2 size surface area may be used to lift a man from the ground. The wing membrane can comprise any lightweight flexible material such as polythene, the material simply being glued in place, trimmed, and the ends folded around wing frame portions, e.g. made from carbon fibre rods.

The drive assembly can be made from light and strong materials, such as a composite material. The flying device, including drive assembly, can be made as small as an insect, such as a wasp, or large enough to lift a man from the ground. The drive assembly could be driven by a motor or a glow plug engine with extended drive shafts acting as wing shafts, and so eliminating the need for a gear assembly.

An adjustable and deflected angle of rotation can be provided by adding a universal joint on each wing shaft, between the motor/engine and the wing mechanism. This would allow the wing mechanism to be fixed in position, and operated above, below, or to the rear of a central point of rotation. The wing mechanism could be arranged to mimic the movement of any flying insect, from a Damseifly to a Goliath Beetle, or a Humming Bird.

It is a feature of the present invention that it can enable a-device to take off from a standing start, hover, fly backwards, forwards, and sideways, and turn on a five pence piece.

Any drive mechanism can be used and the apparatus can be driven by any means e.g. motor, engine, linear motor, or possibly even pedal power.

The mechanism of the present invention can be use for propulsion through any fluid e.g. through air as well as water.

The mechanism of the invention can also be adapted for the purpose of manipulating a multi articulating leg mechanism capable of emulating an insect walking gate in which case the support member is attached to a first part of the leg mechanism and the second mounting point attached to a second part of the articulating leg so that a walking motion is imparted to the leg.

The invention is illustrated in the accompanying drawings in which
Figs. 1 to 5 show one embodiment of the invention and Figs. 6 to 11 show a second embodiment of the invention

Referring to figs. 1 to 5
- Figs. 1 and 2 show details of the drive mechanism
Figs. 3 and 4 show details of the steering control mechanism and
Fig. 5 shows an assembled wing

Referring to figs. 1 and 2 the mechanism consists of a guide rail (01) attached to a control member (02). There is a wing cam (04) which drives cam follower (03) and which rotates about central pivot point (14). The wing (15) is attached to wing sleeve

angular wing motion cam (04) has a wing angle cam follower (03) connected by a ball and socket joint to a front surface of the component. The other end of the wing angle cam follower (03) is connected to the wing angle guide (13). In motion the angular wing motion cam (04) rotates leading the bottom end of wing cam follower (03) around with it, because it is also connected to the wing angle guide (13). The rotating motion of the wing angular wing motion cam (04) imparts a repetitive upwards and downwards motion of the wing angle guide (13), this movement is controlled by the guide rail/control member (01).

The wing angle guide (13) is in turn connected to two ball and sockets joints (10) by means of a bar. The ball and sockets joints (10) are connected to bearings at the base of the wing sleeve (05). As the wing angle guide moves up and down the ball and socket joints (10) which are connected to the bearings pull the wing sleeve (05) back and forwards in a rotating motion around wing shaft (07), which changes the angle of attack of the wing in a controllable manner as they flap up and down.

Referring to figs. 3 and 4, moving the control member (01) left and right, will cause the wings to lower and raise, if the left wing dips the mechanism flies left and if the right hand wing dips the mechanism flies right.

Referring to fig. 5 the wing comprise a flexible membrane stretched over a lightweight frame connected to the mechanism so the wing flexes as the mechanism operates to generate both lift and forward motion. By adjusting the controls the device can be made to hover or move in any direction.

Figs. 6 to 10 show a different embodiment of the invention

Referring to fig. 6. In this embodiment there is a universal joint which links the two motions of the wing.

In the mechanism there is a Main Drive Axle (01) connected to a motor which is the essential Power source; generating a powerful Circular motion through the Main Drive Axle (01).

To produce rotation of the Wing Shaft (07): Located halfway along the Main Drive Axle (01) is the Universal Joint (03). The Universal Joint has two worm wheel Gears (03a) (fig. 1a) that sit either side of the Main Drive Axle (01) as shown with arrows, in motion the Main Drive Axle (01) is powered by the motor producing clockwise rotation, this causes the Universal Joint (03) to rotate through the Worm Wheel Gears (03a) creating a simultaneous similar motion in the wing shaft (07) shown in fig. 6. The Motor powers the Main Drive Axle (01) in a clockwise rotation, the Universal Joint causes the wing shaft to rotate in an identical manner.

To produce the linear flapping motion of the wings: Further along, the Main Drive Axle (01) is fixed to the Cam (02), which is positioned at the front of the mechanism. The motor generates motion in the Main Drive Axle (01) creating Circular motion through the centre of the mechanism to the Cam (02) causing the Cam (02) to also rotate in a clockwise direction. There is a circle set in to the front surface of the Cam (02) located off centre, this is the Cam Groove (05). The Cam Groove (05) maintains an off centre position as the Cam (02) rotates with the Main Drive Axle (01).

Referring to fig.7, located at the front of the mechanism positioned across the front of the Cam (02) is a Cam Follower (04), This component can move up and down along the control member which runs through it, it also has a pin positioned in the centre, which travels through the Cam Follower (04) and sits in the Cam Groove (05). In Motion The Main Drive Axle (01) is rotating causing the Cam (02) to rotate, because the cam follower pin is sitting in the Cam Groove(05), this causes the Cam Follower (04) to move up and down along the Control Member (06) as the Cam (02) rotates. The Cam Follower (04) in when motion moves up and down following the Cam Groove (05).

Located at either end of Cam Follower (04) are two Pushrods (08). Each Pushrod (08) is connected at a Pivot Point (11). The Pivot Points (11) rotate the Pivot Rod (11a) through a set angle as the Push Rods (08) move up and down. The Pivot Rods(11a) are fixed to the Wing Shaft (07) at right angles. In motion the Cam follower (04) moves up and down causing the pushrods (08) to rotate the Pivot Points(11) which by rotating the pivot points causes the up and down motion of the Wing Shafts (07) via the Pivot Rods (11a). This movement is more clearly illustrated in figs. 8 to 8c.To change the direction of flight: Referring to figs. 9 and 10. of the Mechanism Is the Control Member (17). The control member is fixed to the mechanism through the central pivot point of the Cam (02a) so that as the Cam (02) rotates the Control member maintains its upright position with the Cam Follower (04) moving up and down. The bottom end of the Control Member (17) can be moved to the left or the right independently of the Cam (02) but while still being fixed at the Central Pivot Point of the Cam (02a). When the Control Member (17) is pushed to the left, the path of the Cam Follower, which moves along it, is shifted to the left. This changes the positions of the Push Rods and the range of motion of the Pivot Points, which cause the up and down motion of the wing shaft. This means that the movement of the Wing Shafts on each side of the mechanism is no longer symmetrical which causes a change in the direction of flight, by banking to the left or to the right.

The changing wing movement caused by moving the control member to the left or right is more clearly illustrated in fig. 10. If the control rod is moved so one wing dips and the other is raised the wings to turn as in a banked turn. If the control rod is moved so the wings move about a vertical axis will turn in a flat turn. In practice these two operations can be combined.

Referring to fig. 11. At the base of the Wing Shaft in a fixed position is the Angular Drive Cam (12). It is fixed so that it rotates with the Wing Shaft. On the face of the Angular Drive Cam (12) is an off set circular Groove, the Cam Groove (05a). Around

the outer edge of the Angular Drive Cam (12) sits a Directional Control Ring(1 3). The Directional Control Ring (13)is Static, while the Angular Drive Cam (12) rotates with the Wing Shaft.

To produce and control the angular motion of the wing: The Mechanical Wasp Wing is controlled via a hinged Arm (18), which is fixed to the outer Directional Control Ring (13) at one point, maintaining a static position. The other end of the arm is connected to the wing (14). Part way the along the Arm (18) there is a Cam Follower Pin (16) which sits in the Cam Groove (05a) so, as the Angular drive Cam (12) rotates, the Pin followers the Cam Groove (05a) causing the hinged arm to open and close. The hinged arm is connection to the wing (15) so when the hinged arm is opened and closed the angular direction of the wing is changed.

Claims

1. An apparatus for assisting in flying which incorporates a rotational drive mechanism, which drive mechanism comprises (i) a support member attached to a flexible wing at a first mounting point on the wing (ii) a drive means able to impart a linear oscillation to the support member (iii) a second mounting point on the wing attached to the drive means spaced apart from the support member whereby when the drive mechanism operates the support member moves linearly and the wing flexes due to the relative motion of the support and the second mounting point to produce angular wing movement.

2. An apparatus as claimed in claim 1 in which the drive member is a rotatable offset cam mounted on a back plate at an angle to the back plate with the support member attached to a cam follower and the second mounting point attached to the back plate.

3. An apparatus as claimed in claim 2 in which the cam angle is adjustable.

4. An apparatus as claimed in any one of the preceding in which is a drive shaft connected to the axle of the drive member through a universal joint, the drive shaft and the axle of the drive member being at an angle to each other, there being a rotor connecting member mounted on the drive shaft which is connected to the drive member at one location.

5. An apparatus as claimed in any one of the preceding claims in which the first mounting point is adjacent the leading edge of the wing and the second mounting is nearer the trailing edge of the wing and in use the drive mechanism is configured so that, as the rotor rotates, the leading edge of the wing stays substantially at the front of the wing.

6. An apparatus as claimed in any one of the preceding claims in which the leading

edge of the wing articulates separately from the rest of the wing.

7. An apparatus as claimed in any one of the preceding claims in which the support means is a rod or strut which is pivotally attached along the wing.

8. An apparatus as claimed in any one of the preceding claims in which the back part of the wing is also pivotally mounted along its length to the wing shaft and the trailing edge of the back part of the wing pivots up to 150 degrees (relative to the front part of the wing) around the wing shaft, and back again, while the wing shaft oscillates backwards and forwards on each full wing stroke.

9. An apparatus as claimed in claim 8 in which an articulating member is connected to the trailing edge of the back part of the wing, parallel to the wing shaft and a second member is pivotally connected to the free end of the first member and then connected to the back plate there being a circular offset cam mounted to the main drive shaft and a half round (amplifier) cam mounted to the member connected to the back plate, facing inwards and making edge contact with the offset cam.

10. An apparatus as claimed in claim 8 in which as the offset cam rotates, it causes the middle part of the cam follower member to rise and fall relative to the back plate and when the gap is opened to its widest point, the middle has a much larger gap than where the ends meet, the gap closing in a scissor like manner from corner to middle with the back end of the cam follower member and the edge of the side of the back plate as twin guide rails there being a small bus mounted to a rail via bearings, on the underside of the cam follower arm, and the side of the said portion of the back plate, the rail running the full length around the cam follower member and the said portion of the side of the back plate with the busses being free to move along the rail from end to end and are then pivotally hinged where one edge of one bus joins the other edge of the opposite bus.

11. An apparatus as claimed in any one of the preceding claims in which the support means is a rod or strut which is pivotally attached along the wing.

12. An apparatus as claimed in any one of the preceding claims in which the drive mechanism is arranged such that the drive member follows a generally rotary, preferably circular cyclic motion.

13. An apparatus as claimed in any one of the preceding claims in which each web comprises a lightweight plastics material which is secured to a frame

14. A flying device which incorporates at least two of the apparatus as claimed in any one of the preceding claims together with a motor to rotate the rotor.

15. An apparatus as claimed in any one of the preceding claims in which the drive member is a linear motor with one end of the linear motor being connected to the back-plate, the other end connected directly to the cam follower member in the same position as the cam follower mount.

16. An apparatus as claimed in any one of the preceding claims in which the wing is oscillated simultaneously about an axis and the axis is moved linearly back and forth and the combination of these two movements can give a flexing of the wing to produce lift.

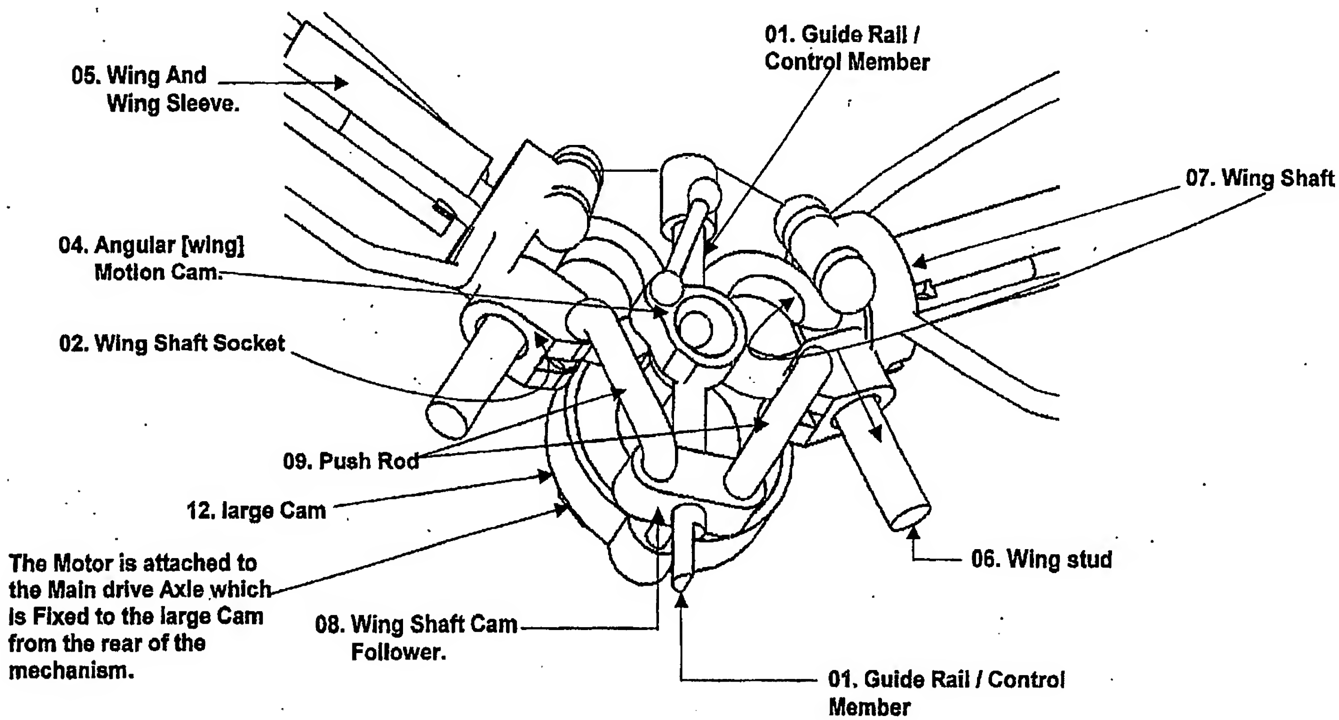
17. An apparatus as claimed in claim 16 in which, by tuning the amplitude and the frequency of the oscillating and linear movements the wing can be made to move so that only lift is generated and substantially no negative lift is generated at any stage.

18. An apparatus as claimed in claim 16 or 17 in which the wing is attached to a sleeve or collar mounted on the axle so that the oscillating motion is imparted by movement of the sleeve over the axle and the axle is moved linearly to generate the linear motion.

Abstract

An apparatus for assisting in flying has a wing attached to a drive mechanism which in which the end of wing is simultaneously oscillated and moved linearly and generates lift.

Fig.1


05. Wing And Wing Sleeve.
04. Angular [wing] Motion Cam.
02. Wing Shaft Socket
09. Push Rod
12. large Cam
The Motor is attached to the Main drive Axle which is Fixed to the large Cam from the rear of the mechanism.
08. Wing Shaft Cam Follower.
01. Guide Rail / Control Member
01. Guide Rail / Control Member
07. Wing Shaft
06. Wing stud

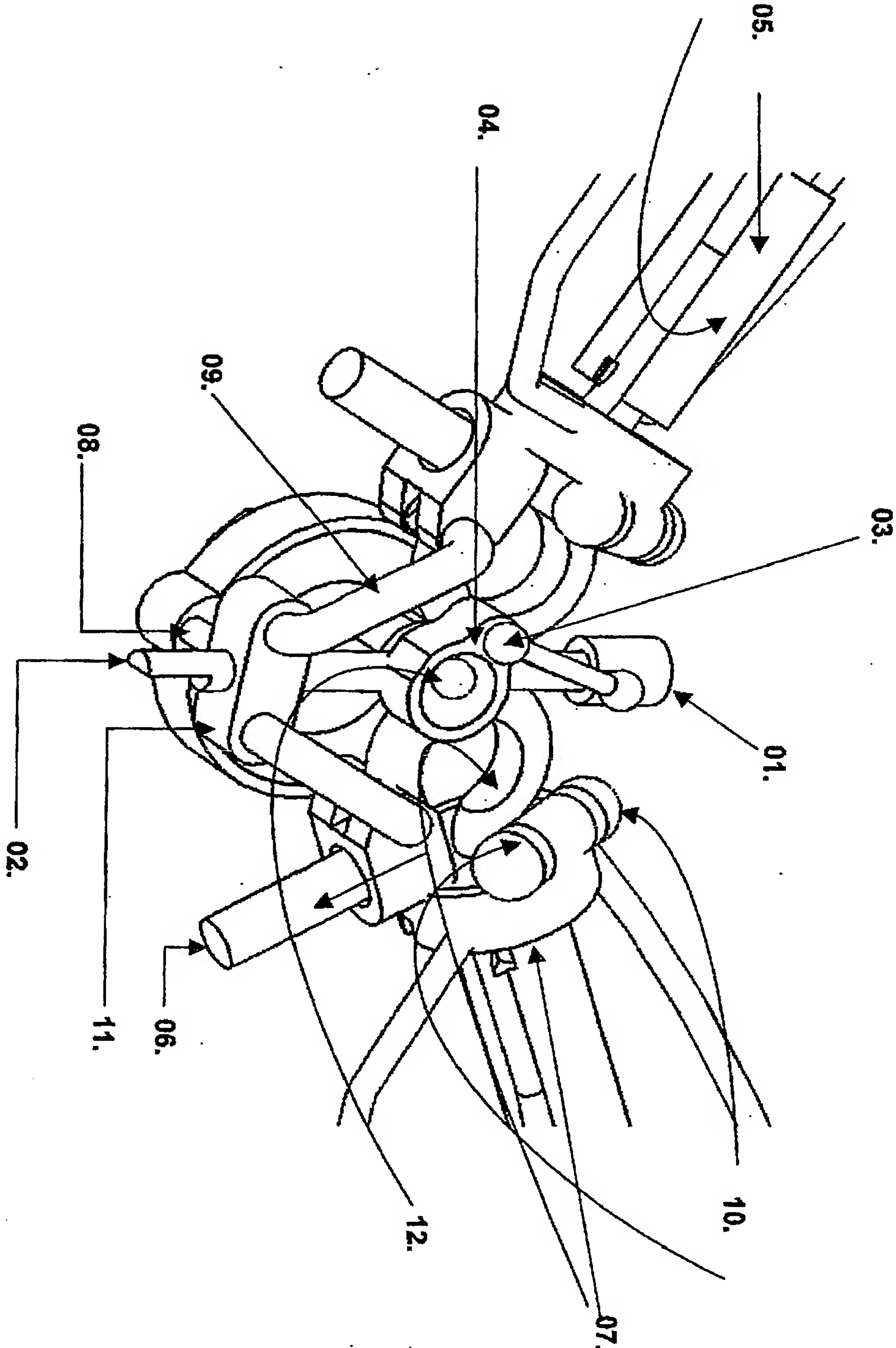
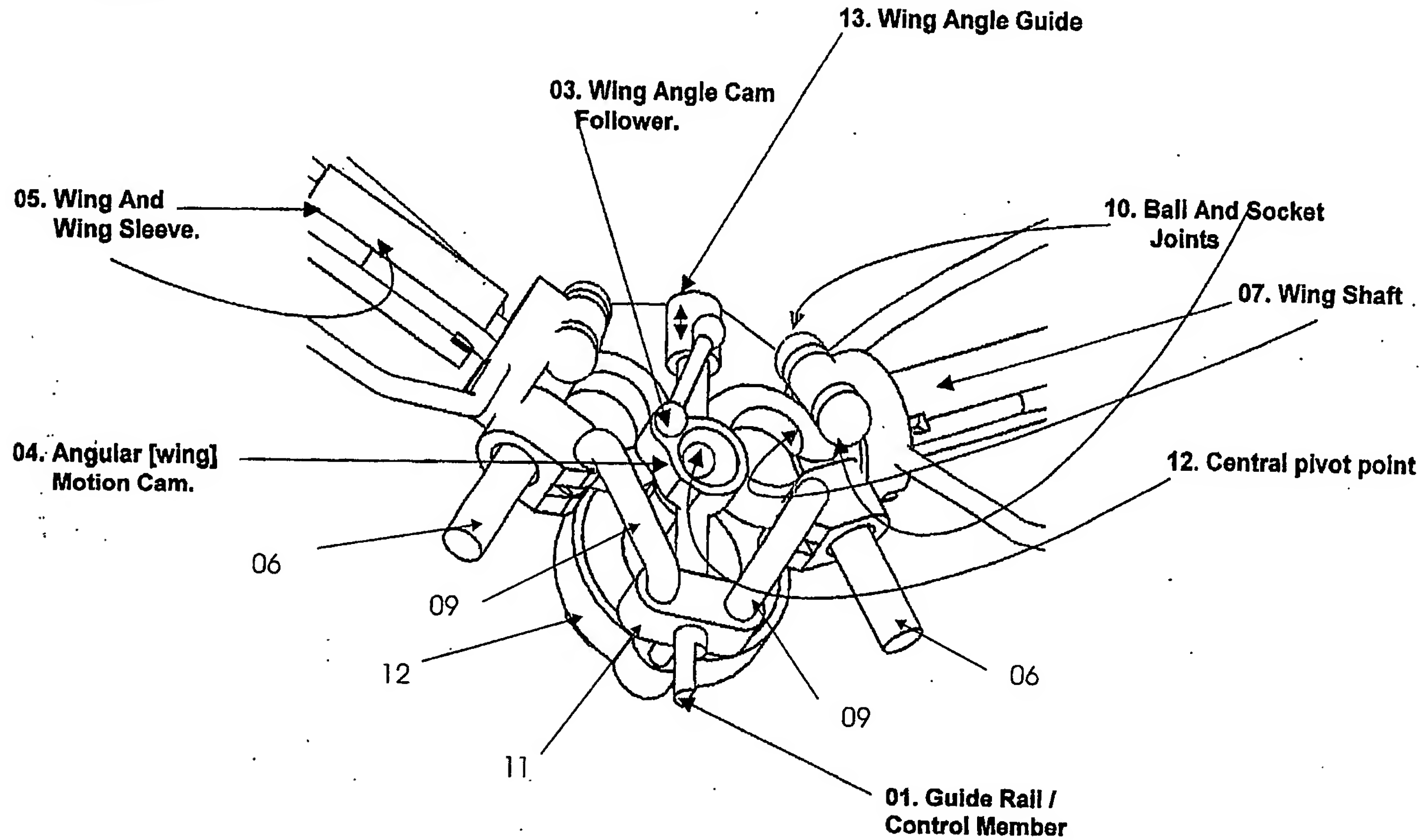


Fig. 1a

Fig.2


13. Wing Angle Guide
03. Wing Angle Cam Follower.
05. Wing And Wing Sleeve.
10. Ball And Socket Joints
07. Wing Shaft
04. Angular [wing] Motion Cam.
12. Central pivot point
06
09
12
06
09
11
01. Guide Rail / Control Member

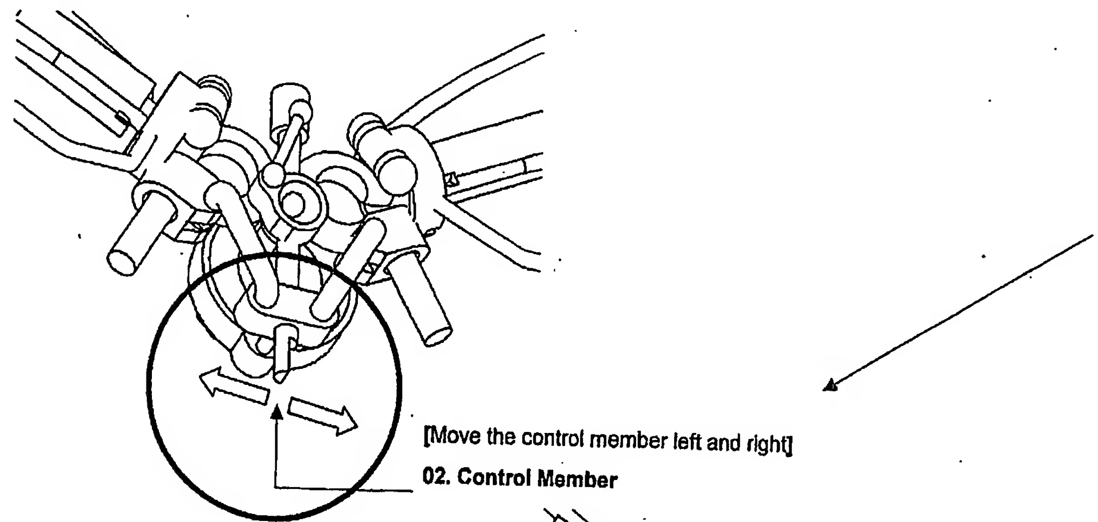

[Move the control member left and right]
02. Control Member

Fig. 4

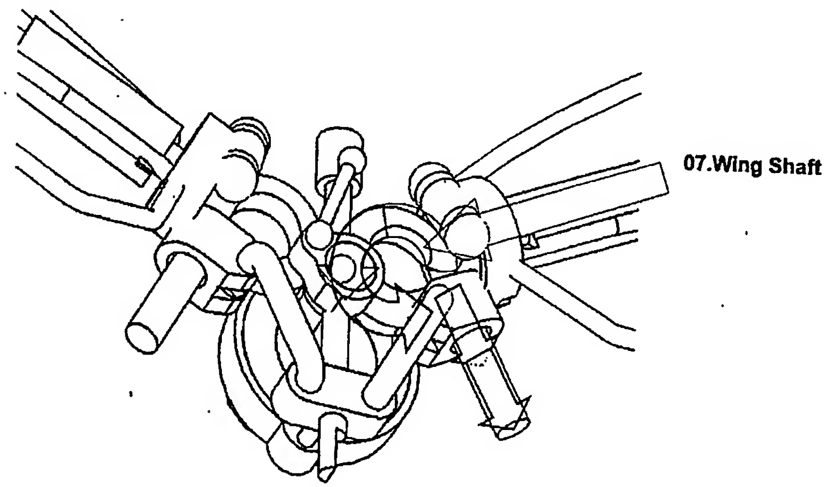

07.Wing Shaft

Fig. 3

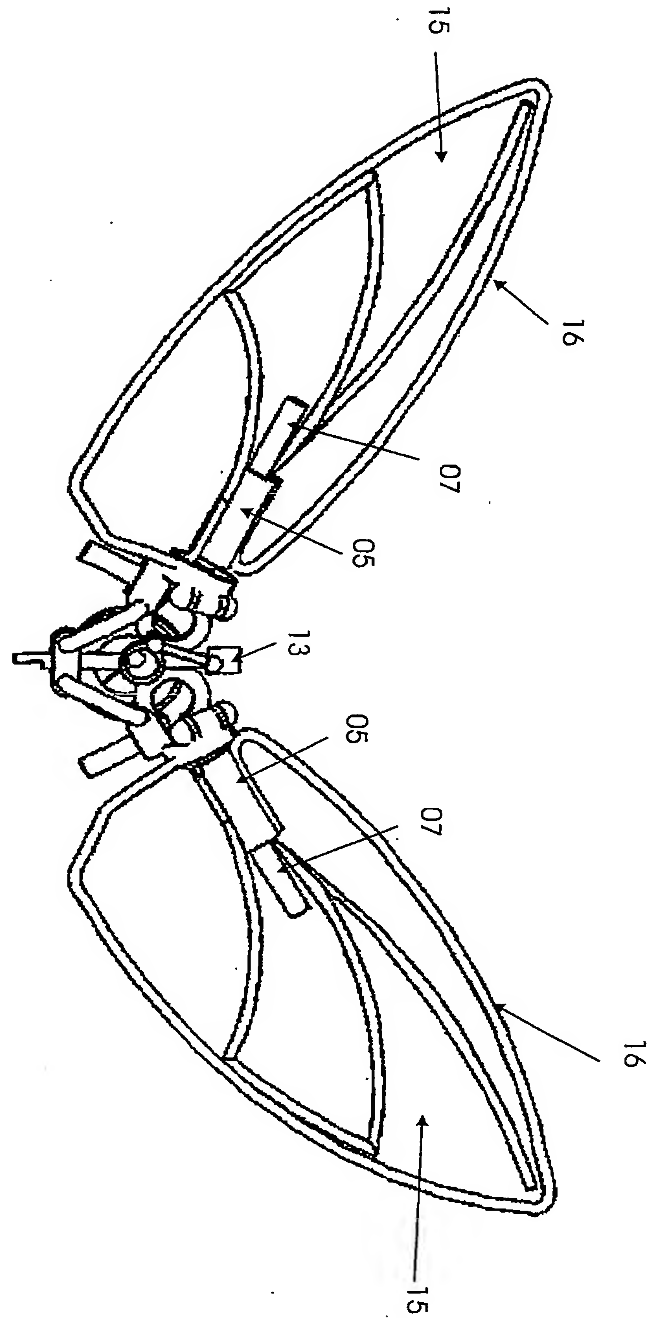


Fig. 5

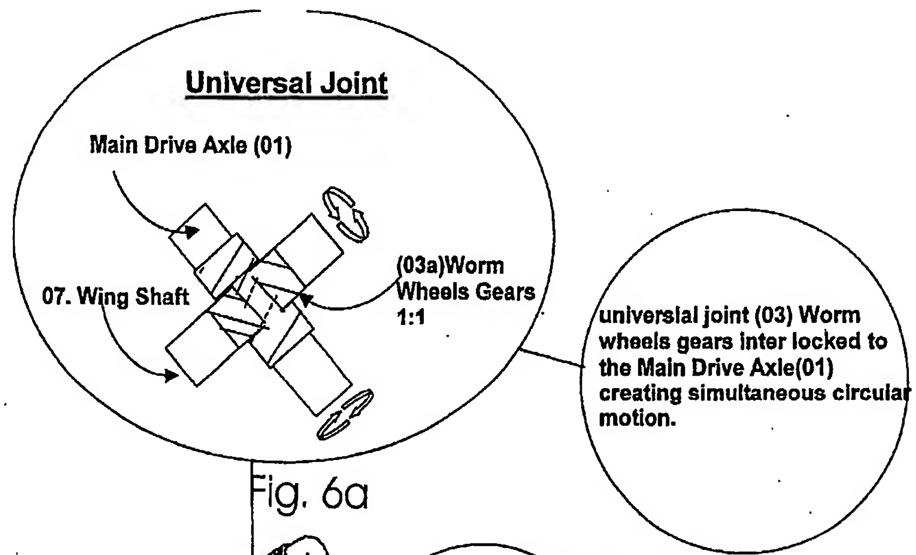

Universal Joint
Main Drive Axle (01)
07. Wing Shaft
(03a)Worm Wheels Gears 1:1
universal joint (03) Worm wheels gears inter locked to the Main Drive Axle(01) creating simultaneous circular motion.

Fig. 6a

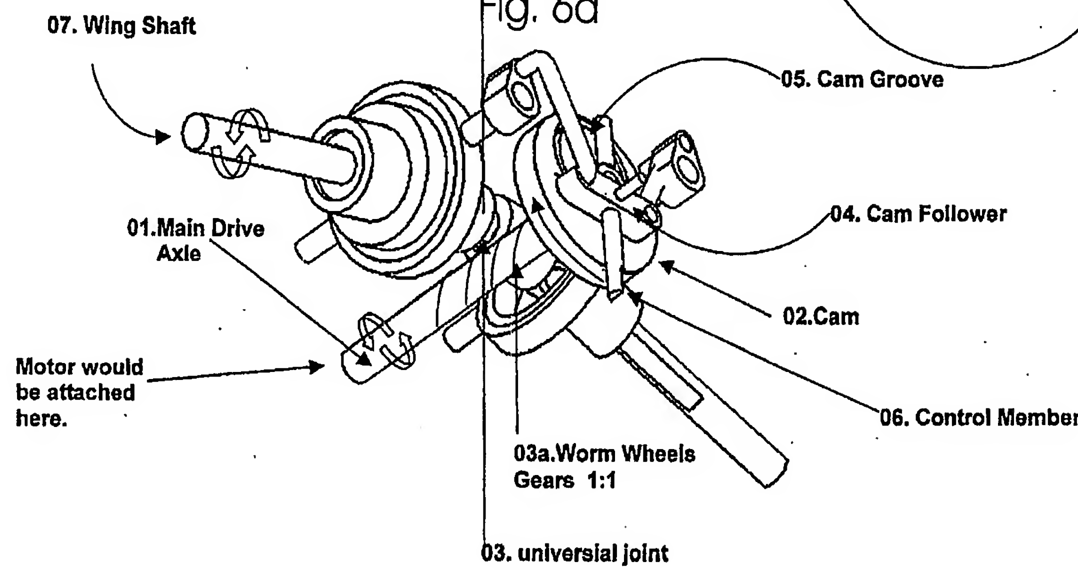

07. Wing Shaft
05. Cam Groove
04. Cam Follower
01.Main Drive Axle
02.Cam
Motor would be attached here.
06. Control Member
03a.Worm Wheels Gears 1:1
03. universal joint

Fig. 6

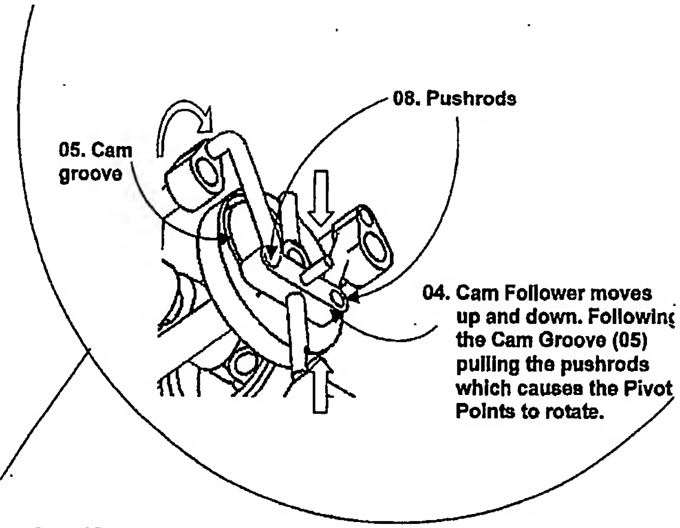

05. Cam groove
08. Pushrods
04. Cam Follower moves up and down. Following the Cam Groove (05) pulling the pushrods which causes the Pivot Points to rotate.

Fig. 7a

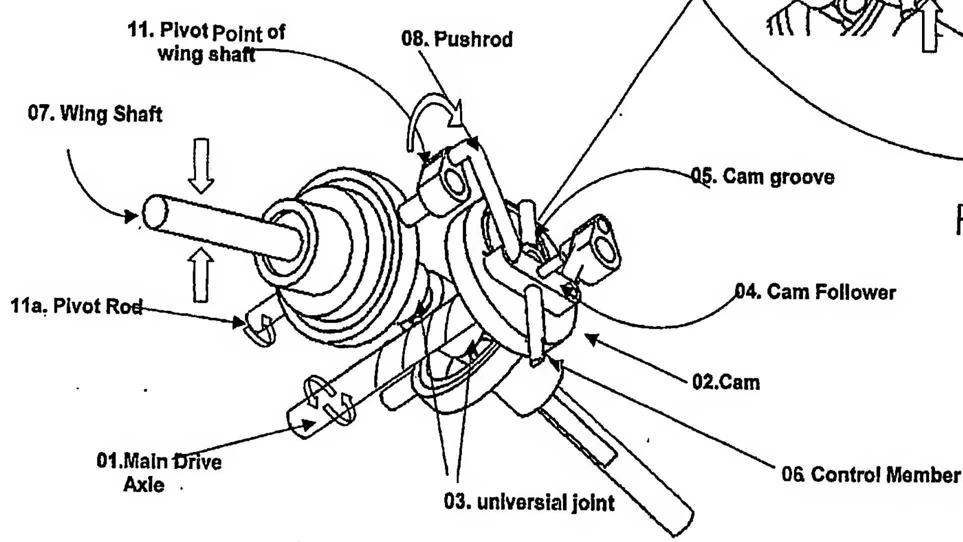

11. Pivot Point of wing shaft
08. Pushrod
07. Wing Shaft
05. Cam groove
04. Cam Follower
11a. Pivot Rod
02.Cam
01.Main Drive Axle
03. universial joint
06 Control Member

Fig. 7

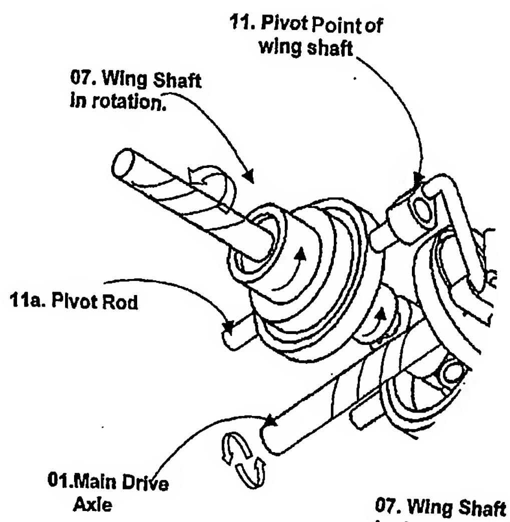


Fig. 8

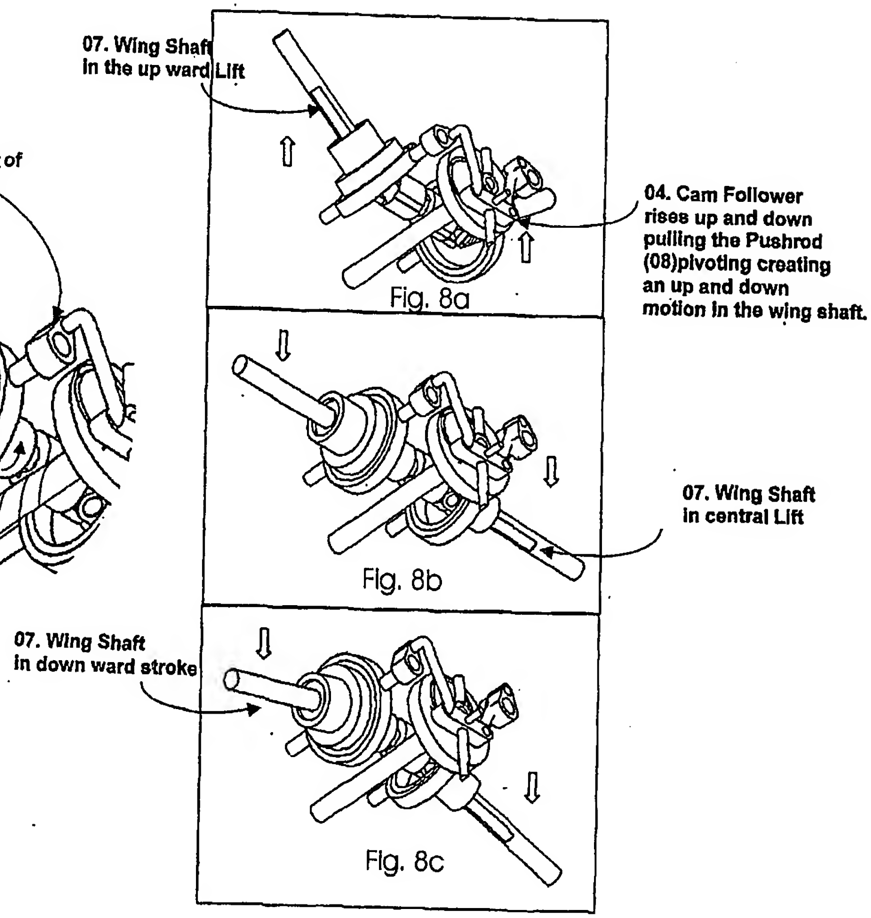
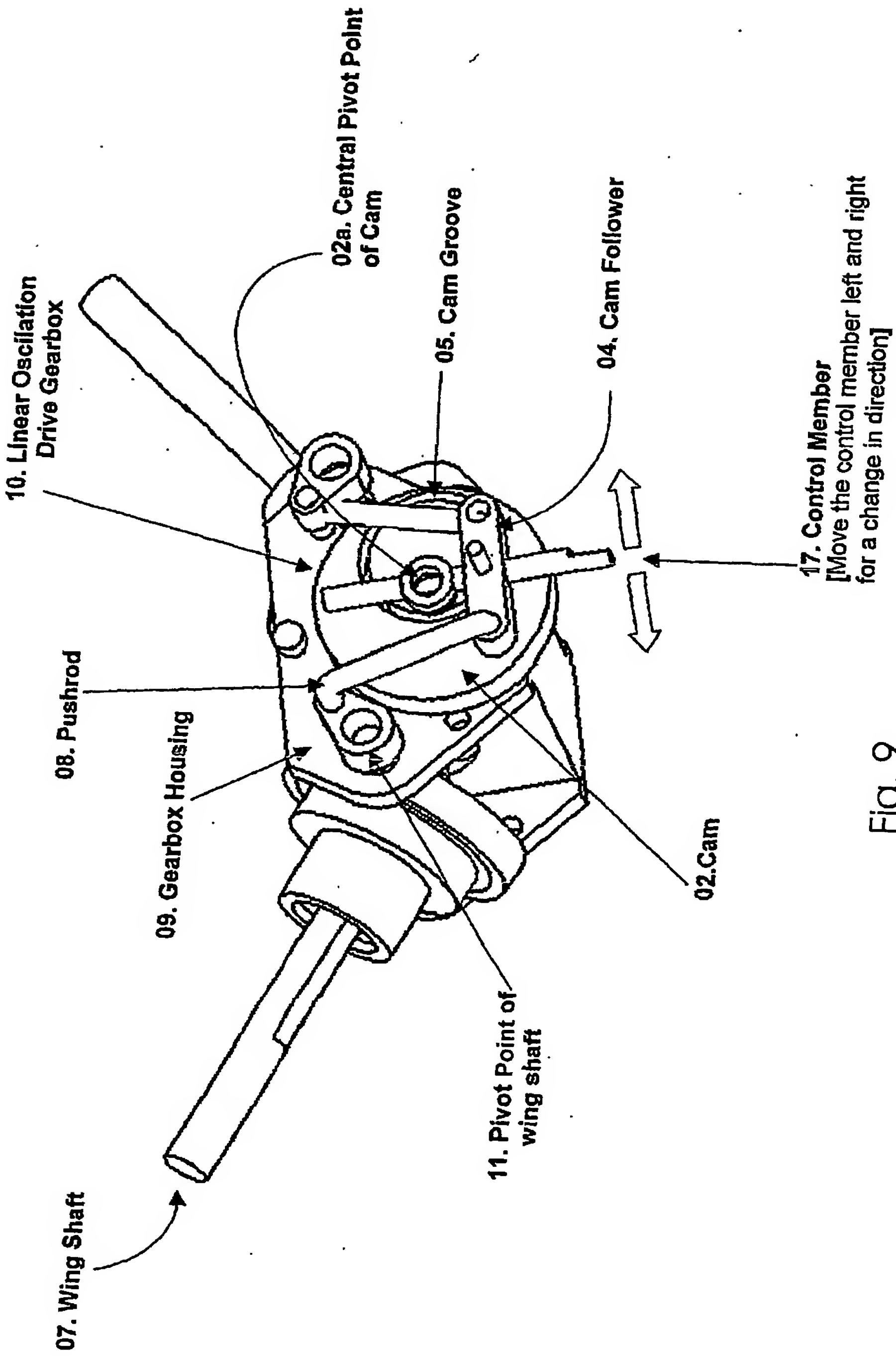


Fig. 8a

Fig. 8b

Fig. 8c



10. Linear Oscillation Drive Gearbox
02a. Central Pivot Point of Cam
05. Cam Groove
04. Cam Follower
17. Control Member
[Move the control member left and right for a change in direction]
08. Pushrod
09. Gearbox Housing
02.Cam
11. Pivot Point of wing shaft
07. Wing Shaft

Fig. 9

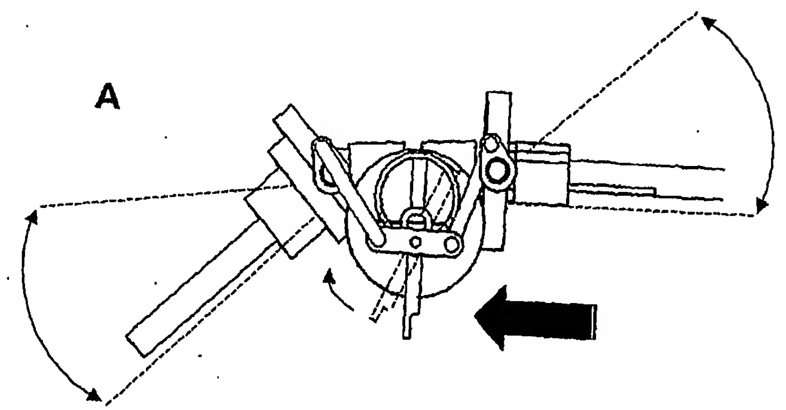


Fig. 10a

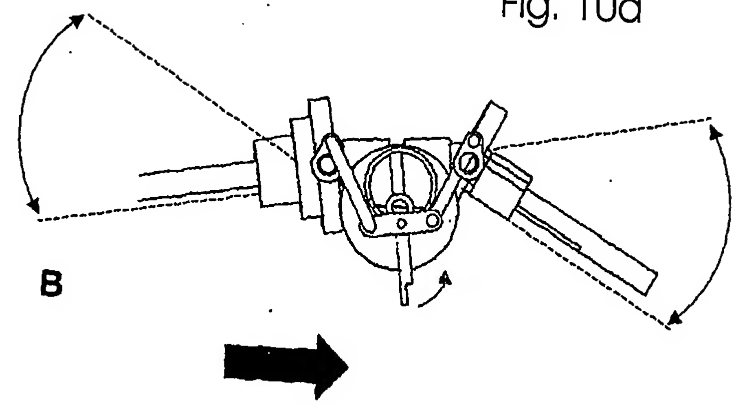


Fig. 10b

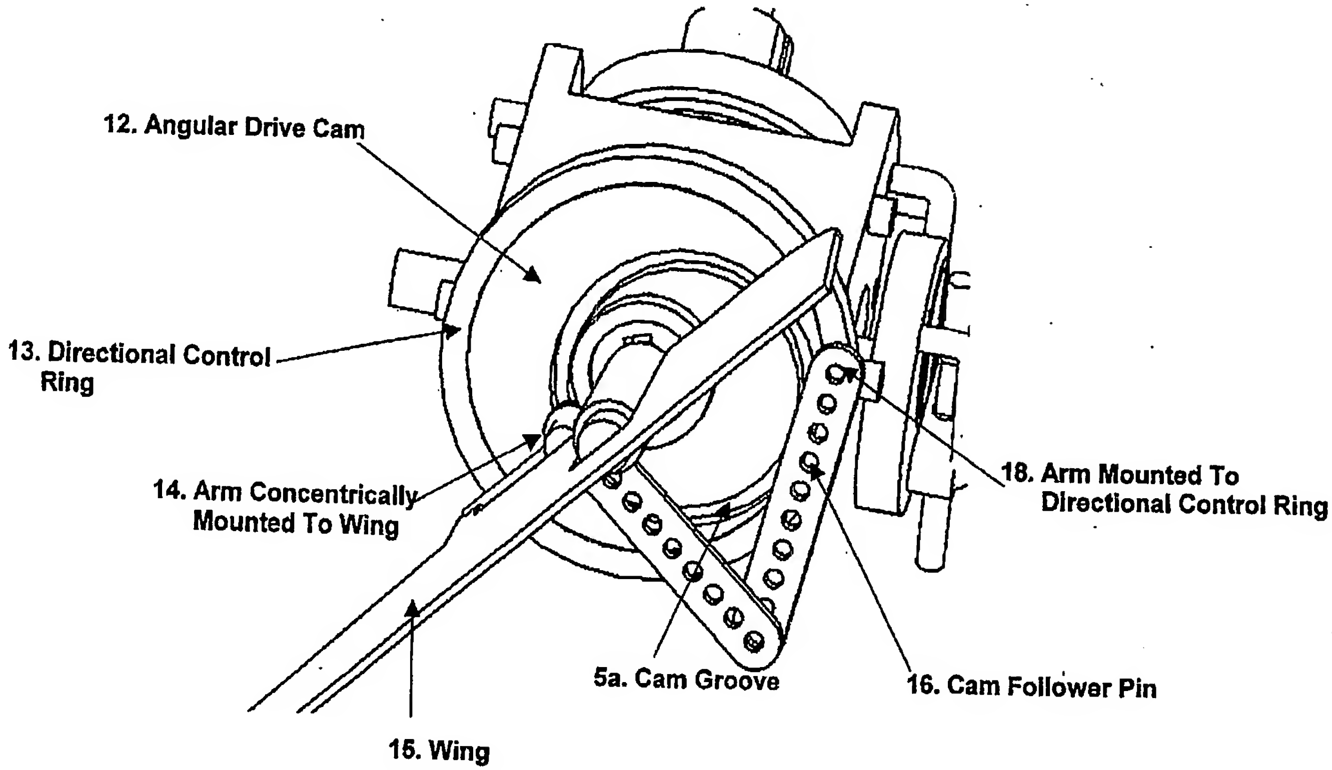

12. Angular Drive Cam
13. Directional Control Ring
14. Arm Concentrically Mounted To Wing
15. Wing
5a. Cam Groove
16. Cam Follower Pin
18. Arm Mounted To Directional Control Ring

Fig. 11

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